Bangladesh Journal of Animal Science 52 (3):61-68, 2023 https://doi.org/10.3329/bjas.v52i3.69206

Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Effects of age on quality of slaughterhouse by-products in Black Bengal goat

MM Hassan, MA Hashem, M Khan ✉

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202.

ARTICLE INFO

Article history:
Received: 09 March 2023
Revised: 12 September 2023
Accepted: 20 September 2023
Published: 30 September 2023

Keywords:
Edible by-products, Inedible by-products, Black Bengal goat, Age group, Proximate components.

Correspondence:
Muckta Khan
✉: muckta.khan@bau.edu.bd

ISSN: 0003-3588

OPEN ACCESS

ABSTRACT

This study was conducted with a view to investigate the yield percentage as well as nutritional composition of slaughterhouse by-products from Black Bengal goats of Bangladesh depending on different age groups. The experiment was conducted in different markets and slaughterhouses of Mymensingh district. Data and samples were collected from 50 (fifty) goats of different ages. Treatment group were executed according to the age, namely T0= 0 permanent incisor teeth (under 1 year), T1= 2 permanent incisor teeth (1 to 1.5 year), T2= 4 permanent incisor teeth (2 years), T3= 6 permanent incisor teeth (2 to 2.5 years), T4= 8 permanent incisor teeth (more than 2.5 years). Live weight, warm carcass weight, dressing percentage, percentage and nutritional composition of different slaughterhouse by-products were measured to identify the variation among the age group. The results showed a wide variation of yield percentage and nutritional composition of edible by-products for different ages of Black Bengal goats. A significant variation ($P>0.01$) of dressing percentage was found with the increase of age. Dressing percentage was 45.87 ± 3.23 in T0 group and 55.94 ± 2.08 in T4 group. Live weight and warm carcass weight were also increased significantly with the increase of age. No significant variation was found in the weight and percentage of different inedible by-products like skin, eye, teeth and hoof as well as edible by-products like liver, brain, kidney, lungs, heart, tongue, intestine with the increase of age. Higher percentage of dry matter and ether extract was found in the liver and heart. Crude protein was almost similar for liver, heart, kidney, lung but pH level was high at kidney. Findings of this investigation of basic properties of edible and inedible by-products of Black Bengal goat will be helpful in livestock researches.

Introduction

Agriculture is a very important sector of the national economy of Bangladesh. The agricultural sectors contribute 14.10 percent to the national GDP of which 2.83 percent is contributed by livestock alone (Bangladesh Economic Review (BER), 2018). Presently, Bangladesh is the second biggest goat milk and goat producing nations on the planet (DLS, 2018). Among the current livestock species cattle, goat, chicken and duck are the most widely recognized. In Bangladesh, goats are second in number of ruminant domesticated animal species in the country. Goats have a huge commitment in GDP through creation of meat, milk and skin addressing about 27.0, 23.0 and 28.0%, individually to the all-out creation from animals' area (FAO, 2009). The skin of the Black Bengal goat specifically is extraordinary all through the world (Habib *et al*., 2001a, and Banerjee, 1989).

How to Cite

MM Hassan, MA Hashem, M Khan (2023). Effects of age on quality of slaughterhouse by-products in Black Bengal goat. *Bangladesh Journal of Animal Science* 52 (3): 61-68. https://doi.org/10.3329/bjas.v52i3.69206

By-products of slaughterhouse implies everything from the abattoir or ordinary butcher's shop that isn't sold straightforwardly as food (Gracey, 1986). Edible and inedible are the most known classification of animal by-products depending on whether they are used as food or not. Based on live weight of the animal the by-products represent for almost 60%, of which 40% are edible and 20% are inedible (Chatli *et al.*, 2005). Instances of edible by-products are offal's like liver, heart, kidney, thymus, pancreas, spleen, lungs and edible fat, while inedible by-products incorporate feet, crude bone, horns, hooves, bile, blood and inedible fat (Anam, 2003). These animal by-products can also be classified on the basis of their ultimate use. These incorporate agricultural by-products (bone meal, meat meal, fertilizer etc.); industrial by-products (glue, gelatin, casings etc.) and pharmaceutical by-products (bio-chemicals, insulin, hormones, pepsin etc.) (Sharma and Sharma, 2011).

The black Bengal goat is a type of goat found all through Bangladesh, Bihar, West Bengal, Orissa locales of north eastern India. The quantity of black Bengal goats is around 260 million in Bangladesh (BER, 2017). An adult male goat weighs around 20 to 30 kg and female 15 to 25 kg. It is extremely famous in Bangladesh in view of its exceptionally low interest in feed and high productivity rate (Barman *et al*, 2017; Habib *et al.*, 2001b; Sarker *et al*., 2008). The Black Bengal goats acquire sexual development at an earlier age than other goat breeds. This variety can adjust effectively to any climate along with its higher disease preventive capacity. Black Bengal goat also produce superior quality chevon and skin than other goat breeds (Husain *et al*., 1996). The edible by-products of goat are especially appealing to wellbeing cognizant gatherings because of its lower fat substance contrasted with different kinds of red meat and in this way gives a fantastic wellspring of low-fat meat entrees (Kawsar *et al*., 2006; Moniruzzaman *et al*., 2002).

Very little research work related to yield and uses of slaughterhouse by-products of Black Bengal goat had been conducted in Bangladesh. Therefore, this study was undertaken to investigate the effect of age on the yield of slaughterhouse by-products and the proximate nutrients of most edible by-products of Black Bengal goat. Present price and uses of the most edible by-products of Black Bengal goat was also studied in the study areas.

Materials and Methods

Site and period of experiment

The experiment was conducted in different markets and slaughterhouses of Mymensingh. Sample and data were collected, and analyzed during March to August 2018. Data were collected through direct interviews and making frequent personal visits. Before making the actual interview, the objectives of the study were explained clearly to the butchers. Then the questions were asked in a very simple manner with explanation whenever necessary. These samples were collected from Mymensingh Municipality Slaughterhouse, Mymensingh, Sutiakhali Bazar, Mymensingh Kewatkhali Bazar, Mymensingh K. R. Market, BAU, Mymensingh.

Data collection and sample preparation

Data of slaughtered Black Bengal goats were collected from different markets and slaughterhouses (n=10 in each group). Goats were selected on the basis of their age. Age of goat was categorized into 5 treatments namely T_0= 0 permanent incisor teeth (under 1 year), T_1= 2 permanent incisor teeth (1 to 1.5 year), T_2= 4 permanent incisor teeth (2 years), T_3= 6 permanent incisor teeth (2 to 2.5 years), T_4= 8 permanent incisor teeth (more than 2.5 years). Live weight (kg), warm carcass weight (Live weight−weight of all by-products), dressing percentage (warm carcass weight / Live weight × 100) and by-products were weighing out using digital weighing balance (WPCS-DS758X (40KG), Bangladesh). All types of by-products (both edible and inedible) such as liver, heart, kidney, brain, lungs, spleen, skin, intestine, hoofs, eye, teeth were collected from about 10 animals of each age group. The information regarding price and uses of most edible by-products were collected from butchers. The most important edible by-products (liver, heart, kidney, lungs and brain) were also collected for chemical analysis. The samples were preserved at -20°C for further analysis.

Proximate analyses

The proximate analysis was conducted at the Animal Science laboratory under the Department of Animal Science, Bangladesh Agricultural University, and Mymensingh. The proximate compositions such as Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Ash content of most important edible by-product samples were analyzed following the methods of AOAC (2005).

pH measurement

The pH of the finely minced (Miyako Meat Chopper/ Meat Grinder MC-75 850WATT, India) sample was determined by the method of Trout (1992). Briefly, for each treatment 5 grams of sample was homogenized with 25 ml of distilled water using pestle and mortar and kept it for 5-7 minutes. Then the pH of the suspension was recorded using a digital pH meter (Hanna HI 99163).

Statistical analysis

Data were analyzed by using MSTAT-C package in one-way analysis of variance test as per Completely Randomized Design (CRD). Means were considered significantly different for (P<0.05) and (P<0.01). Data presented are shown as mean ± SD.

Results and Discussion

Live weight, warm carcass weight, dressing percentage and weight of different by-products

Live weight, warm carcass weight and weight of different by-products of Black Bengal goat on the basis of age are given in Table 1. Significant difference (P<0.05) was observed in warm carcass weight and dressing percentage among the different age groups of Black Bengal goats.

Table 1: Live weight, warm carcass weight, dressing% and weight of by-products (n=10).

Parameters	Treatments						LS
	T_0	T_1	T_2	T_3	T_4	P value	
Live weight (kg)	7.63 ± 0.44	8.43 ± 0.48	9.81 ± 0.64	10.44 ± 0.66	11.60 ± 1.87	0.207	NS
Warm carcass (kg)	3.50± 0.46	4.20± 0.69	5.15± 0.43	5.55± 0.55	6.49 ± 0.99	0.01	**
Dressing (%)	45.87± 3.23	49.82± 5.78	52.49± 1.73	53.16± 2.15	55.94± 2.08	0.01	**
Head (kg)	1.06 ± 0.90	1.17 ± 0.07	1.31 ± 0.11	1.24 ± 0.05	1.31 ± 0.01	0.064	NS
Liver (kg)	0.48 ± 0.03	0.48 ± 0.01	0.49 ± 0.01	0.50 ± 0.01	0.51 ± 0.01	0.364	NS
Heart (kg)	0.17 ± 0.00	0.17 ± 0.00	0.18 ± 0.00	0.18 ± 0.00	0.20 ± 0.00	0.207	NS
Kidney (kg)	0.15 ± 0.00	0.16 ± 0.00	0.16 ± 0.00	0.17 ± 0.01	0.18 ± 0.00	0.064	NS
Lungs(kg)	0.20 ± 0.01	0.20 ± 0.01	0.20 ± 0.00	0.21 ± 0.01	0.26 ± 0.01	0.364	NS
Brain (kg)	0.07 ± 0.00	0.07 ± 0.00	0.07 ± 0.00	0.08 ± 0.00	0.09 ± 0.00	0.272	NS
Skin (kg)	1.35 ± 0.06	1.51 ± 0.02	1.60 ± 0.02	1.70 ± 0.02	1.80 ± 0.02	0.580	NS
Intestine(kg)	1.20 ± 0.05	1.30 ± 0.02	1.35 ± 0.03	1.40 ± 0.01	1.49 ± 0.02	0.064	NS
Tongue (kg)	0.05 ± 0.00	0.05 ± 0.00	0.05 ± 0.00	0.05 ± 0.00	0.06 ± 0.00	0.272	NS
Eye (kg)	0.02 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.270	NS
Teeth (kg)	0.18 ± 0.00	0.18 ± 0.00	0.19 ± 0.00	0.20 ± 0.01	0.21 ± 0.01	0.364	NS
Hoof (kg)	0.24 ± 0.01	0.24 ± 0.00	0.24 ± 0.02	0.25 ± 0.00	0.26 ± 0.01	0.580	NS

*T0, 0 permanent incisor teeth (under 1 year); T1, 2 permanent incisor teeth (1 to 1.5 years); T2, 4 permanent incisor teeth (2 years); T3, 6 permanent incisor teeth (2 to 2.5 years) and T4, 8 permanent incisor teeth (more than 2.5 years); * , 5% level of Significance; **, 1% level of significance; LS, Level of Significance; NS, non-significant;*

Table 2: Percentage of different by-products on live weight basis (n=10).

Parameters	Treatments					Level of significance
	T_0	T_1	T_2	T_3	T_4	
Live weight (kg)	7.63 ± 0.44	8.43 ± 0.48	9.81 ± 0.64	10.44 ± 0.66	11.60 ± 1.87	NS
Head	10.48 ± 7.07	10.5 ± 7.11	10.27 ± 6.88	11.08 ± 6.10	11.13 ± 6.18	NS
Brain	0.73 ± 0.49	0.65 ± 0.44	0.59 ± 0.40	0.57 ± 0.38	0.62 ± 0.42	NS
Lungs	1.94 ± 1.30	1.79 ± 1.21	1.57 ± 1.05	1.52 ± 1.02	1.9 ± 1.24	NS
Heart	1.71 ± 1.15	1.56 ± 1.05	1.4 ± 0.94	1.32 ± 0.89	1.43 ± 0.98	NS
kidney	1.52 ± 1.02	1.39 ± 0.94	1.29 ± 0.86	1.27 ± 0.86	1.28 ± 0.87	NS
Liver	4.7 ± 3.14	4.33 ± 2.91	3.86 ± 2.58	3.66 ± 2.45	3.58 ± 2.43	NS
skin	13.37 ± 8.96	13.59 ± 9.14	12.56 ± 8.39	12.47 ± 8.34	12.6 ± 8.56	NS
Intestine	11.92 ± 8.00	11.72 ± 7.86	10.62 ± 7.11	10.27 ± 6.88	10.43 ± 7.08	NS
Tongue	0.49 ± 0.33	0.45 ± 0.30	0.4 ± 0.27	0.36 ± 0.24	0.39 ± 0.28	NS
Eye	0.17 ± 0.11	0.22 ± 0.15	0.19 ± 0.12	0.18 ± 0.12	0.18 ± 0.12	NS
Teeth	1.83 ± 1.23	1.62 ± 1.08	1.5 ± 1.00	1.48 ± 0.99	1.44 ± 0.97	NS
Hoof	2.38 ± 1.60	2.16 ± 1.44	1.89 ± 1.27	1.8 ± 1.21	1.8 ± 1.22	NS

*T_0, 0 permanent incisor teeth (under 1 year); T_1, 2 permanent incisor teeth (1 to 1.5 years); T_2 ,4 permanent incisor teeth (2 years); T_3,6 permanent incisor teeth (2 to 2.5 years) and T_4= 8 permanent incisor teeth (more than 2.5 years); *, 5% level of Significance; ** , 1% level of significance; NS, non-significant;*

Highest carcass weight (kg) was (6.49 ± 0.99) obtained in the T_4 group and lowest in T_0 group (3.50± 0.46). Similar effects of age on warm carcass weight and carcass weight were obtained by Banerjee and Shanthi (2012) who conducted an experiment on the carcass and meat quality of farmed elk. Yagoub and Babiker (2008) reported that carcass weight increased with the increase of dietary level and age. The significant (P<0.05) difference is also observed in dressing percentage among the groups. Highest dressing percentage (55.94 ± 2.08) was obtained in

the T_4 group and lowest (45.87 ± 3.23) in the T_0 group.

Table 3: Proximate nutrients and pH value of liver (n=6).

Parameters	Treatments					P value	LS
	T_0	T_1	T_2	T_3	T_4		
DM (%)	25.10±1.32	25.21± 3.91	24.43±5.24	29.85± 4.62	33.92±1.93	0.064	NS
CP (%)	18.90^{a}± 0.06	18.34^{c}± 0.06	18.80^{b}±0.09	18.87^{ab}± 0.02	18.91^{a}±0.02	0.001	**
EE (%)	13.30^{a}± 1.04	11.76^{b}± 1.66	10.50^{c}± 0.70	10.09^{c} ± 1.59	12.26^{b}±1.85	0.001	**
ASH (%)	3.61 ± 0.77	3.85 ± 0.92	4.15 ± 0.88	5.51 ± 1.56	4.68 ± 1.03	0.272	NS
pH	5.86^{c}± 0.04	5.90^{bc}± 0.03	5.94^{b}± 0.02	6.01^{a}± 0.04	6.04^{a}± 0.02	0.001	**

*T0, 0 permanent incisor teeth (under 1 year); T1, 2 permanent incisor teeth (1 to 1.5 years); T2, 4 permanent incisor teeth (2 years); T3, 6 permanent incisor teeth (2 to 2.5 years) and T4, 8 permanent incisor teeth (more than 2.5 years); *, 5% level of Significance; **, 1% level of significance; LS, Level of Significance; NS, non-significant. Means with different superscripts within the row are significantly different. Values are Mean ±SD.*

Table 4: Proximate nutrients and pH value of heart (n=6).

Parameters	Treatments					P value	Level of Significance
	T_0	T_1	T_2	T_3	T_4		
DM (%)	29.05^{b} ±0.91	28.20^{c} ±1.20	30.28^{a} ± 0.18	29.37^{b} ± 0.61	32.26^{a} ±0.58	0.001	**
CP (%)	16.43^{c}± 0.49	17.48^{b}±0.16	18.49^{a} ± 0.23	18.51^{a} ± 0.05	18.90^{a}±0.12	0.001	**
EE (%)	10.01^{b} ± 1.69	10.29^{b} ±1.98	12.55^{ab} ± 0.91	17.89^{a} ± 2.06	18.83^{a} ± 1.37	0.015	*
Ash (%)	2.83^{ab} ± 0.72	2.15^{b}± 0.92	2.35^{b} ±0.92	3.96^{a} ± 0.92	4.05^{a}± 0.04	0.037	*
pH	6.01^{a}± 0.03	5.97^{b}± 0.01	5.87^{c}± 0.02	5.75^{d}± 0.03	5.71^{e}± 0.02	0.001	**

*T0, 0 permanent incisor teeth (under 1 year); T1, 2 permanent incisor teeth (1 to 1.5 years); T2, 4 permanent incisor teeth (2 years); T3, 6 permanent incisor teeth (2 to 2.5 years) and T4, 8 permanent incisor teeth (more than 2.5 years); * , 5% level of Significance; **, 1% level of significance; NS, non-significant. Means with different superscripts within the row are significantly different. Values are Mean ±SD.*

Table 5: Proximate nutrients and pH value of kidney (n=6).

Parameters	Treatments					P value	Level of Significance
	T_0	T_1	T_2	T_3	T_4		
DM (%)	21.53^{a}± 2.25	17.94^{b}± 0.42	17.37^{b}± 1.03	17.75^{b}± 0.43	18.07^{b}± 1.19	0.008	**
CP (%)	17.91^{d}± 0.08	18.08^{c}± 0.08	18.31^{b}± 0.08	18.45^{b}± 0.04	18.66^{a}± 0.13	0.001	**
EE (%)	2.03^{b}± 0.33	3.3^{b}± 0.30	1.99^{b}± 0.51	4.64^{ab}± 1.07	5.90^{a}± 5.43	0.035	*
Ash (%)	1.61^{b}± 0.70	2.77^{b}± 2.13	4.24^{a}± 1.69	2.03^{b}± 0.96	5.35^{a}± 0.77	0.006	**
pH	6.56^{b}± 0.02	6.60^{a}± 0.01	6.60^{a}± 0.01	6.61^{a}± 0.01	6.60^{a}± 0.02	0.013	*

*T_0, 0 permanent incisor teeth (under 1 year); T_1 , 2 permanent incisor teeth (1 to 1.5 years); T_2, 4 permanent incisor teeth (2 years); T_3, 6 permanent incisor teeth (2 to 2.5 years) and T_4, 8 permanent incisor teeth (more than 2.5 years); * , 5% level of Significance; ** , 1% level of significance; means with different superscripts within the row are significantly different. Values are Mean ± SD.*

Table 6: Proximate nutrients and pH value of Lungs (n=6).

Parameters	Treatments					P value	Level of Significance
	T_0	T_1	T_2	T_3	T_4		
DM (%)	16.57 ± 1.41	17.24 ± 1.95	16.75 ± 1.99	16.81 ± 1.15	18.93 ± 4.93	0.364	NS
CP (%)	17.78^{d}± 0.10	18.07^{c}± 0.15	18.36^{g}± 0.06	18.71^{a}± 0.09	18.81^{a}± 0.11	0.001	**
EE (%)	1.27^{a}± 0.06	0.77^{c}± 0.06	1.08^{b}± 0.13	1.06^{b}± 0.04	1.06^{b}± 0.09	0.001	**
ASH (%)	1.79^{c}± 0.64	1.71^{c}± 1.18	2.96^{bc}± 1.33	5.71^{a}± 1.17	4.33^{ab}± 0.30	0.003	**
pH	5.96^{c}± 0.03	6.00^{b}± 0.01	6.03^{ab}± 0.01	6.02^{ab}± 0.02	6.04^{a}± 0.01	0.001	**

*T_0 , 0 permanent incisor teeth (under 1 year); T_1 , 2 permanent incisor teeth (1 to 1.5 years); T_2 , 4 permanent incisor teeth (2 years); T_3 , 6 permanent incisor teeth (2 to 2.5 years) and T_4 , 8 permanent incisor teeth (more than 2.5 years); * , 5% level of Significance; ** , 1% level of significance; means with different superscripts within the row are significantly different. Values are Mean ± SD.*

Rao, *et al*. (2009) also found an increased dressing percentage with the increase of certain age in non-descript buffalo. The result showed that there were no significant differences in the weight of head, skin, intestine, tongue, eye, teeth, hoof, liver, heart, kidney, lungs and brain among the different treatment groups (Table 1).

Percentage of different by-products based on live weight

The percentage of various by-products based on live weight of Black Bengal goats were presented in Table 2. No significant variations were observed in the percentage of different by-products. Among the edible by-products the liver is the highest percent and among the inedible by-products hides is the

highest percent on the basis of live weight (Table 2) were estimated resemble to findings of Hossain *et al.* (2002); Kawsar *et al.* (2006) and Moniruzzaman *et al*. (2002).

Proximate components and pH value of most important edible by-products of Black Bengal goat

The proximate composition of most important edible by-products like liver, heart, kidney, lungs and brain of Black Bengal goat were analyzed. The highest value of CP percentage was found in T_4 group for all edible by-products.

Table 7: Proximate nutrients and pH of brain (n=6).

Parameters	Treatments					P value	Level of Significance
	T_0	T_1	T_2	T_3	T_4		
DM (%)	19.17 ± 0.37	18.14 ± 3.03	21.28 ± 3.90	20.65 ± 2.16	20.34 ± 1.50	0.580	NS
CP (%)	12.24^{d}±0.13	12.53^{c}± 0.07	12.80^{b}± 0.09	13.09^{a}± 0.07	13.21^{a}± 0.20	0.001	**
EE (%)	5.25^{a}± 0.13	5.09^{b}± 0.22	5.13^{b}± 0.09	4.76^{c}± 0.03	4.41^{d}± 0.04	0.001	**
Ash (%)	2.21 ± 0.40	2.17 ± 0.53	2.43 ± 0.87	3.27 ± 0.82	2.87 ± 0.99	0.207	NS
pH	6.60^{a}± 0.10	6.32^{b}± 0.03	6.35^{b}± 0.01	6.29^{b}± 0.02	6.33^{b}± 0.01	0.001	**

*T_0 , 0 permanent incisor teeth (under 1 year); T_1, 2 permanent incisor teeth (1 to 1.5 years); T_2, 4 permanent incisor teeth (2 years); T_3, 6 permanent incisor teeth (2 to 2.5 years) and T_4, 8 permanent incisor teeth (more than 2.5 years); * , 5% level of Significance; ** , 1% level of significance; means with different superscripts within the row are significantly different. Values are Mean ± SD.*

Table 8: Price and uses of most edible by-products**.**

By-products	Price BDT/Kg	Uses
Liver	480-580	Liver is used as human consumption. It is also used in research purpose and feed of pet animal like dog. Sometimes liver price is higher than chevon.
Heart	450-500	It is used for human consumption. It is also used in research purpose. Normally it is sold with meat.
Kidney	400-500	It is used for human consumption. Along with it is also used in research purpose. Normally it is sold with meat.
Lungs	250-350	It is used for human consumption. It is also used as pet animal feed. Normally it is sold at a low price compared with slaughterhouse by-products
Brain	550-600	Brain is used for human consumption. It is also used in research purpose. Every now and then it is sold with head.

Liver

The result of proximate components of liver shown in Table 3. There was no significant difference in DM (24.43±5.24 to 33.92±1.93%) in different treatment groups. Billah *et al.* (2021) also found DM 19.89± 3.90 to 31.21± 6.01 in different treatment groups of sheep which were insignificant. Ash (3.631.21± 6.011 ± 0.77 to 5.51 ± 1.56%) in different treatment groups which were insignificant, Billah *et al.* (2021) also found insignificant Ash content in sheep experiment. A significant change was found in CP, EE and pH in different treatment groups. The highest values of CP (18.91±0.02%) and pH (6.04± 0.02%) were found in T_4 group, highest EE (13.30± 1.04%) was found in T_0 group which is agreed with the result of Billah *et al.* (2021).

Heart

The results of proximate components of heart presented in Table 4. The highest values of DM (32.26 ±0.58%), CP (18.90±0.12%), EE (18.83± 1.37%), Ash (4.05± 0.04%) and pH (5.71± 0.02%) were found in T_4 group, which is agreed with the results of Anderson (1988) in comparison and nutritional value of edible meat by-products.

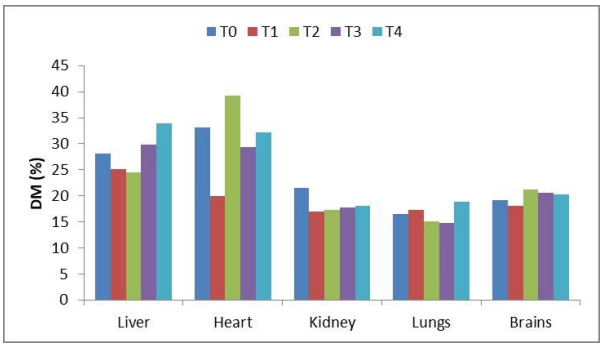

Fig 1: The percentage of DM in most edible by products of Black Bengal goat

Kidney

As shown in Table 5, the highest values of CP (18.66± 0.13%), EE (5.90± 5.43%), and Ash (5.35± 0.77%) were found in T_4 group (P<0.01), but the highest DM (21.53± 2.25%) was found in T_0 group. The highest pH level (6.60±

0.02%) is observed in T_4 group (P<0.01), agreed with the result by Okanovic *et al.* (2009) who conducted an experiment on physico-chemical qualities of goat and sheep by-products.

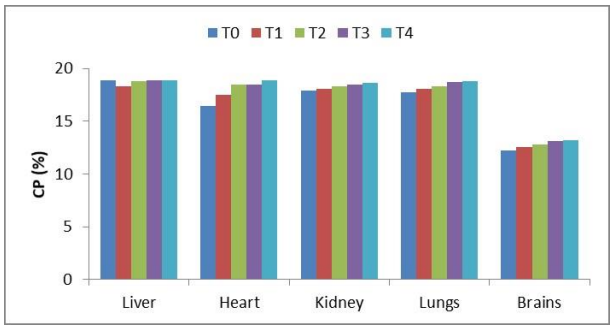

Fig 2: The percentage of CP in most edible by-products of Black Bengal goat

Lungs

The result of the proximate component and pH value of lungs presented in Table 6. DM percentage was relatively higher in T_4 (18.93 ± 4.93) than other groups but non-significant. CP (18.81± 0.11%) and EE (1.06± 0.09%) were higher (P<0.01) in T_4 than other groups. Highest Ash percentage (5.71± 1.17) was observed in T_3 group. The highest pH level (6.04± 0.01) is observed in T_4 group (P<0.01), agreed with the result of Billah *et al.* (2021).

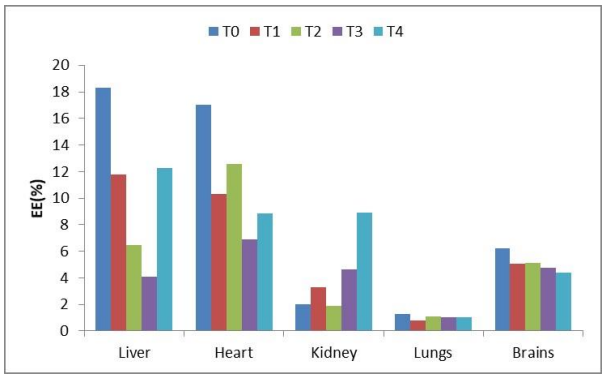

Fig 3: The percentage of EE in most edible by products of Black Bengal goat

Brain

The result of the proximate component of the brain presented in Table 7. No significant change was observed in DM and Ash percentage. The highest value of CP (13.21± 0.20%) was found in T_4 group. Highest values for EE (5.25^a± 0.13%) and pH (6.60± 0.10) were found in T_0 group (P<0.01).

Comparison among different edible by-products

The DM percentage of most important edible by-products are shown in Figure 1. DM was higher in liver and heart of all age groups but relatively lower in kidney, Lungs and brain of all age groups. Figure 2 indicated the comparison of CP% among the different edible by-products. The CP percentage was overall the same in liver, heart, kidney, lungs but relatively lower in brain. The percentage of EE had been presented in Figure 3.

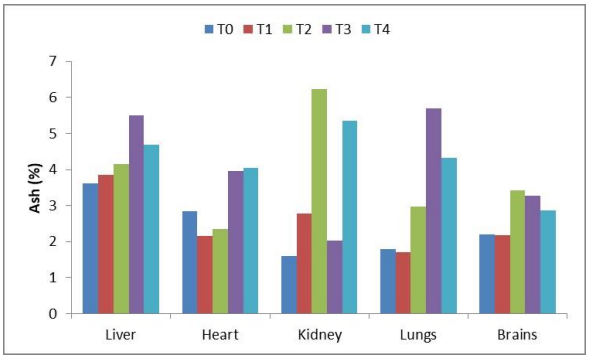

Fig 4: The percentage of Ash of most edible by products of Black Bengal goat

The lowest percentage of EE was found in Lungs at all age groups than all other edible by-products. The percentage of ash in most edible by-products were exhibited in Figure 4. Relatively lower Ash values were found in the brain than other edible by-products. The value of pH in most edible by-products were shown in Figure 5. Highest pH values were found in the kidney in all age groups than all other edible by-products. Billah *et al.* (2021) also found comparable results in sheep research.

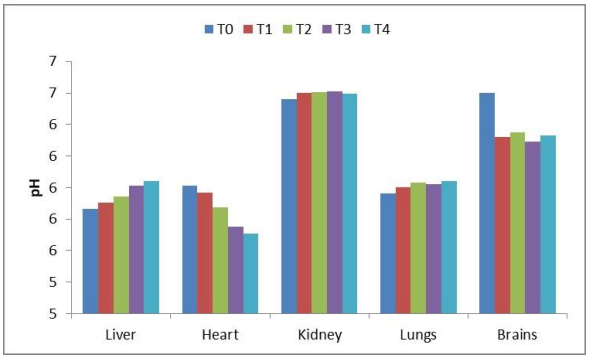

Fig 5: The value of pH in most edible by products of Black Bengal goat

Price and uses of the most edible by-products

The price and uses of most edible by-products presented in Table 8. Price of edible by-products was almost the same as meat when measured with weight. Sometimes the price fluctuates. Sometimes liver is sold at higher price than the main products in selling centers. Animal by-products also serve as an extra means for the butcher to earn revenue or as a cushion to cover losses from the cost of purchasing the live animal exceeding the selling price of the carcass.

Conclusion

In summary the findings of this study show that age of Black Bengal goat has great impact of variation on the live weight, carcass weight and nutritional composition of different edible slaughterhouse by-products, although, no significant variation was found on the percentage of different edible and inedible by-products like head, tongue, skin, hooves, teeth, eye, liver, brain, kidney, heart, lungs on the basis of live weight of Black Bengal goat. Warm carcass weight and dressing percentage increased with the increase of age. Crude protein content also similarly increased for edible by-products. Higher EE content in liver, lung and brain was found in younger goats whereas the higher EE content in heart and kidney was found in older goats, probably due to unknown nutritional background. With the increase of age the ash content increased in the heart and kidney of Black Bengal goats. With the increase of age pH value was increased in liver, kidney and lung, but with the increase of age pH value was decreased in heart and brain. Findings of this investigation of basic properties of edible and inedible by-products of Black Bengal goat will be helpful in livestock researches.

Acknowledgement

The authors are grateful to the Department of Animal Science of Bangladesh Agricultural University for providing essential and logistic supports for conducting the research.

Author's contribution

Md. Mehedi Hassan: Execute the research trial, lab analysis, data analysis and manuscript writing; Md. Abul Hashem: Helped in experimentation, manuscript writing and editing; Muckta Khan: Conceptualizing, planning and overall supervision of the research.

Conflict of interest

The authors declare no conflict of interest.

Consent to participate

The authors provide full consent to participate as per need.

Consent for publication

All the author has fully agreed to publish this research in Bangladesh Journal of Animal Science.

References

Anam, Q.A. (2003). Influence of types of preservatives and freezing time on the quality of beef. MS thesis, Department of Animal Science, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh.

Anderson, B.A. (1988). Composition and nutritional value of edible meat by-products. *Edible Meat By-Products, Advances in Meat Research*, 5: 15-45.

AOAC (2005). Official Methods of Analysis. Association of Official Analytical Chemists (20 Ed), Washington, D.C., U.S.A.

Rao VA, Thulasi1, G., Wilfred Ruban, S. and Thangaraju, P. (2009). Optimum Age of Slaughter of Non-Descript Buffalo: Carcass and Yield Characteristics. *Thai Journal of Agricultural Science*, 42(3): 133-138.

Banerjee, P., Shanthi, C. (2012). Isolation of novel bioactive regions from bovine Achilles tendon collagen having angiotensin I-converting enzyme-inhibitory properties. *Process Biochemistry,* 47(12): 2335–2346. https://doi.org/10.1016/j.procbio.2012.09.012

Banerjee, G. C. (1989). A text book of Animal Husbandry. 7th edition, Oxford and IBH publishing Co. India.

Bangladesh Economic Review (BER), (2017). Finance Division, Ministry of Finance and planning, Government of the People's Republic of Bangladesh.

Bangladesh Economic Review, (2018). Finance Division, Ministry of Finance and planning, Government of the People's Republic of Bangladesh.

Barman, T.C., Hossain, M.M., Rahman, M.M., Ali, M.Y., Sarker, N.R. (2017). An assessment of socio-economic conditions of the farmers related to goat fattening in Rangpur district of Bangladesh. *Asian Australas. J. Food Saf. Secur.*, 1 (1), 1-6. https://doi.org/10.3329/aajfss.v1i1.55755

Billah, M.M., Islam, S.M.A, Khan, M. **(**2021). Investigation on the quantity and nutritional composition of slaughterhouse by-products of indigenous sheep. Journal of Agriculture, food and environment, 2(1): 97-101. https://doi.org/10.47440/JAFE.2021.2117

Chatli, M.K., Padda, G.S., Devatkal, S.K. (2005). Augmentation of animal By-products processing for the sustainability of meat industry. *Indian Food Industry,* 24(5): 69-73.

DLS (Department of Livestock Services), (2018). http://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40ac_8bd9_898fb8ee4700/Livestock%20Economy%20at%20a%20glance%20%20%282017-2018%29.pdf

FAO, (2009). Trade and Markets, Economic and Social Development, Food and Agriculture Organization of the United Nations.

Gracey, J.F., (1986). Meat Hygiene, Eighth edition. English Language Book Society. Bailliere Tindall, UK. pp. 495-497.

Habib, S., Rahman, M.M., Hashim, M.A., Mahbub-E-Elahi, A.T.M. (2001a). Effects of castration on body weight gain in Black Bengal goats. *Progressive Agriculture*, 12: (1-2) 127-130.

Habib, S., Islam, M.N., Rahman, M.M., Hashim, M.A. (2001b). Effects of castration on serum cholesterol level and hematological values in Black Bengal goats. *Bangladesh J. of Anim. Sci*., 30 (1-2): 49-53.

Hossain, M.I., Hossain, M.M., Hashem, M.A., Ahmed, M. (2002). Uses of slaughterhouse byproducts in Bangladesh. *Bangladesh Journal of Animal Science,* 31: 37-43.

Husain, S.S., Horst, P., Islam, A.B.M.M. (1996). Phenotypic selection on the improvement of growth performance of Black Bengal kids. Asian-Australasian Journal of Animal Sciences, 9 (2): 149-153. https://doi.org/10.5713/ajas.1996.149

James, B., Lee, C.W., Park, B.K., Lee, S.M., Kwon, E.G., Im, S.K., Jeon, G.J., Park, Y.S., Hong, S.K. (1997). Studies on growth performance and meat quality improvement of the unselected Hanwoo bulls in the performance test. *Journal of Animal Science and Technology*, 52(5): 427. https://doi.org/10.5187/JAST.2010.52.5.427

Kawsar, S.M., Rahman, M.M., Rahman, S.M.E., Hossain, M.M., Huq, M.A. (2006). Growth, carcass and non-carcass traits of Black Bengal goats due to urea molasses block supplementation. International Journal of Bio-Resources, 2(1): 1-5.

Moniruzzaman M, Hashem MA, Akhter S, Hossain MM, (2002). Effect of Different Feeding Systems on Carcass and Non-Carcass Parameters of Black Bengal Goat. Asian-Australasian Journal of Animal Sciences, 15(1): 61-65. https://doi.org/10.5713/ajas.2002.61

Okanovic, D., Ristic, M., Tasic, T., Ikonic, P., Popvic, M., Gubic, J. (2009). Chemical characteristics of cattle slaughtering by-products for technical processing. *Biotechnology in Animal Husbandry,* 25: 785-790. https://doi.org/10.2298/BAH0902143O

Sharma, B.D., Sharma, K. (2011). Outlines of Meat Science and Technology. *Jaypee Brothers Med. Publ. Ltd*., 360.

Sarkar, M.M., Hossain, M.M., Rahman, M.M., Rahman, S.M.E. (2008). Effect of feeding urea molasses block on the productive and reproductive performances of Black Bengal doe. *Bangladesh J. of Agril. Univ*. 6(1): 39-46.

Trout, G. R. (1992). Proc. 38th. Inter. Congr. Meat Sci. Technol., France. pp. 983.

Yagoub, Y.M., Babiker, S.A. (2008). Effect of dietary energy level on growth and carcass characteristics of cattle in Sudan. Tamil nadu. *Journal of Veterinary and Animal Science,* 7:102-106.